AN: PAT 1979-J6742B
TI: Diesel engine waste heat recovery appts. includes heat exchanger extending sinuously along gas pass acting as exhaust duct from engine
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PD: 10.10.1979
AB: The appts. includes a gas pass (1) acting as an exhaust duct from e.g. a diesel engine, disposed below the lower end of the pass (1). A heat exchanger (2) is located within the gas pass and extends sinuously from side to side in a vertical plane. A recirculation duct (3) contg. a fan (5) and a control valve (6), extends from a location in the gas pass (1) downstream of the heat exchanger (2) to a location upstream of the exchanger. A fluidised bed combustor (10) is mounted adjacent the gas pass (1) and is arranged so that combustion gases escaping from it can flow into the gas pass (1) through the opening through which the duct (3) discharges into the gas pass (1). Tube lengths (11) are immersed in the fluidised bed and are connected in series with the tube lengths included in the heat exchanger (2). They are supplied with water or steam from an inlet header (12).;
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# (54) IMPROVEMENTS IN OR RELATING TO WASTE HEAT RECOVERY APPARATUS

(71) We, BABCOCK & WILCOX LIMITED, a British Company of Cleveland House, 19, St. James's Square, London, SW1Y 4LN, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

Waste heat recovery systems have grown in importance both afloat and ashore since the depletion of energy sources has been brought into perspective. Energy saving systems such as waste heat recovery are now widely used. Heat exchangers utilising the heat content of the exhaust gas stream from diesel engines and from a gas turbine engine are common. Such a system designed to operate efficiently at normal load can, however, present difficulties when the engine is operating at partial load since the heat available in the exhaust gas stream is much reduced.

It has already been proposed to provide for the burning of additional fuel in the gas stream when the heat in the gas stream from the engine is not sufficient to meet the needs of the heat exchanger. Such direct combustion, however, would normally result in a radiant heat loading, and a maximum gas temperature, in excess of that for which the exchange is designed and to compensate for this it has been proposed that the fuel should be burnt with large amounts of excess air, resulting in a low efficiency.

The present invention arose from a consideration of the problems presented by variations in the heat available in the hot gases used in waste heat recovery apparatus.

According to the present invention there is provided waste heat recovery apparatus having a gas pass connected to receive an exhaust gas stream from an engine and containing heat exchange tubes, a fluidised bed combustor arranged to supply hot gases to the gas pass upstream of the heat exchange tubes, and means by which heat may be extracted from the fluidised bed.

By way of example, an embodiment of the invention will now be described with reference to the accompanying, somewhat schematic drawing illustrating a waste heat recovery apparatus.

The apparatus illustrated in the drawing includes a gas pass 1 acting as an exhaust duct from a main engine, such as a diesel engine, disposed below the lower end of the pass 1 and not shown in the drawing. Within the gas pass 1 is a heat exchanger 2 extending sinuously from side-to-side in a vertical plane. A recirculation duct 3, containing a fan 5 and control valve 6, extends from a location in the gas pass 1 downstream of the heat exchanger 2 to a location upstream of the heat exchanger 2.

Adjacent the gas pass 1, there is mounted a fluidised bed combustor 10 so arranged that combustion gases escaping from the combustor 10 can flow into the gas pass 1 through the opening through which the duct 3 discharges into the gas pass 1. The combustor 10 occupies comparatively little space.

Tube lengths 11 are immersed in the fluidised bed of the combustor 10 and connected in series with the tube lengths included in the heat exchanger 2. They are supplied with water or steam from an inlet header 12.

In using the apparatus that has been described, the combuster 10 is operated when the heat in the waste gases flowing into the gas pass 1 from the engine is insufficient to heat the tubes of the heat exchanger 2 adequately. Whilst the combustor 10 is operating, the bed is cooled by fluid flowing through the tubes 11; the coefficient of heat exchange between the bed and the tubes 11 is very high so that only a small surface area is required. As a result of the cooling effected by the tubes immersed in the bed, combustion takes place at low temperatures, the resultant temperature of the gases leaving the bed is comparatively

low, and there is sufficient gas flow at a temperature low enough to avoid exposing the tubes of the heat exchanger 2 to a high radiant heating that would be liable to damage the tubes or finning.

If the combustor 10 is so operated that the gases leaving the fluidised bed are to hot for admission directly to the gas pass 1, they are cooled by mixing with gases recirculated through the duct 3. The recirculation that is required to attemperate the gases flowing from the combustor 10, since the gases leaving the fluidised bed 10 are not at a high temperature, can be expected to be small so that only a small recirculating fan is likely to be needed on that account. Whether or not recirculation is required, the temperature of the gases flowing into the pass 1 from the combustor 10, and serving to heat the gases flowing into the gas pass 1 from the engine, is kept low.

In the apparatus that has been described, the combustor 10 need be of only a small size to provide sufficient heating capacity. The combustor 10 can be operated efficiently with only a relatively small excess of air.

Since the bed of the combustor 10 is cooled by the flow of fluid that subsequently flows to the heat exchanger, this pre-heating of the fluid reduces the amount of heat that need be supplied to the heat exchanger.

In the apparatus that has been described, the tubes 11 are not finned. In alternatives, they may be finned or otherwise extended. It is also envisaged that tubes immersed in the fluidised bed may serve for the superheating of steam, so that use of the combustor results in the provision of superheated steam, by which the quantity of steam required is reduced and the overall efficienty of the plant is increased.

WHAT WE CLAIM IS:—

1. Waste heat recovery apparatus having a gas pass connected to receive an exhaust gas stream from an engine and containing heat exchange tubes a, fluidised bed combustor arranged to supply hot gasses to the gas pass upstream of the heat exchange tubes, and means by which heat may extracted from the fluidised bed.

2. Apparatus as claimed in Claim 1 in which the means by which heat may be extracted from the fluidised bed includes tubes disposed within the bed and through which a cooling fluid may be passed.

3. Apparatus as claimed in Claim 2 in which the tubes disposed within the bed are connected in series with the heat exchange tubes that are disposed within the gas pass.

4. Apparatus is claimed in any of Claims 1 to 3 in which means is provided for recirculating gases from a location downstream of heat exchange tubes to a location upstream of the heat exchange tubes.

5. Apparatus as claimed in claim 4 in which the inlet to the gas pass for the hot gases is the same as the inlet to the gas pass for the recirculated gases.

6. Apparatus as claimed in any of the preceding claims in which the heat exchange tubes are finned.

7. Apparatus as claimed in any of the preceding claims in which the means by which heat may be extracted from the fluidised bed includes tubes in which steam is superheated.

8. Apparatus as claimed in any of the preceding claims in which the means by which heat may be extracted from the fluidised bed includes finned tubes.

9. Waste heat recovery apparatus substantially as described with reference to, and as illustrated by the accompanying drawing.

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